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ABSTRACT

A mathematical model that describes attitude change in human communication networks is developed in this paper. The parameters of the model are drawn from a review of the literature related to network analysis, small group influence, mass communication, and attitude change. The literature review identifies key variables that influence attitude change in social networks, including those of valuation, strength, apprehension, rate of contact, accumulated information, and the discrepancy between the initial attitudes of two communicators. Including these variables, the final mathematical model ultimately predicts that in most social systems there will be "pools" of disparate attitudes that are a result of group influence processes, out-group communication, and the relative rates of communication in a human communication network. The paper concludes with a discussion of the importance of these findings for organizational communication, mass communication, diffusion, and small group research. An extensive bibliography is also provided. (HOD)

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A MATHEMATICAL MODEL OF THE EFFECTS OF INTERNAL GROUP PRESSURES, OF GROUP COMMUNICATION, AND OF OUT-GROUP COMMUNICATION ON ATTITUDE CHANGE IN HUMAN COMMUNICATION NETWORKS

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ABSTRACT

The formation of attitudes in human communication networks has long been a crucial concern in a number of areas of human communication inquiry. This paper presents a mathematical model of this phenomenon partially derived from the work of French, Abelson, and Taylor, who assume a discrepancy model of attitude change. These approaches to modeling attitude change in human communication networks neglect the influence of small groups and mass communication. This paper reviews these two bodies of literature to isolate those variables that can most properly be added to a more inclusive model of attitude change in communication networks. The final model, that results from empirical findings in the literature, ultimately predicts that in most social systems there will be 'pools' of disparate attitudes that are a result of group influence processes, out-group communication, and the relative rates of communication in a human communication network. The paper concludes with a discussion of the importance of these findings for organizational communication, mass communication, difussion, and small group research.

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A MATHEMATICAL MODEL OF THE EFFECTS OF INTERNAL GROUP PRESSURES, OF GROUP COMMUNICATION, AND OF OUT-GROUP COMMUNICATION ON ATTITUDE CHANGE IN HUMAN COMMUNICATION NETWORKS

This paper seeks to develop a mathematical model, based on several diverse literatures, that will describe attitude change in human communication networks. The networks involved will typically be composed of various groupings of individuals who receive some messages from other groupings within the network and/or sources that interface with the network. Thus the parameters in the model will be drawn from four primary literatures: network analysis, small group influence, mass communication (especially diffusion of innovations approaches), and attitude change.

The network analysis literature will be reviewed to develop a framework for examining communication patterns in social groupings, especially important here are the notions of integration and differentiation (Katz & Kahn, 1966), or the extent to which a network is tied together by recurring communication linkages. Typically, in any large social system a network will be divided into diverse groupings of individuals who come to adopt unique perspectives, often associated with their functions (e.g. Lawrence & Lorsch, 1968). These diverse groupings naturally result in unique 'pools', or clusterings, of attitudes associated with their inherent communication structures and with group influence processes (Danowski, 1974; Danowski & Farace, 1974; Taylor, 1976).[1]

Thus to adequately explain attitude change in networks group influence processes must be taken into account. To this end the group influence literature will be reviewed to isolate those variables that determine attitude change within groups. But even though groups' exercise significant

pressures on individuals to adopt common attitudes on salient issues, it is still a commonplace observation that attitudes change in communication networks. To account for this change, any model must also identify those sources of change attributable to communication across system interfaces. Thus the model will seek to identify the relative impacts of messages that are sent across group and other system interfaces. Group interfaces are primarily determined by individuals who have communication linkages with other groups, and thus could be described in terms of the conventional group literature as having multiple group membership (Cartwright & Zander, 1968b; Killian, 1962). Parameters will be identified from reviewing the group literature that determine an individual's tendency to adopt an attitude that is a function of all of the groups to which he belongs. To the extent the network is diffuse; that is there are a number of linkages across groups, the model will predict that eventually a network will come to reflect attitudes that are similar across all groupings (Abelson, 1964). However, this would only happen in a closed system, in most human communication networks a substantial source of instability in attitude formation is represented by mass communication channels that cut across system interfaces. Thus the mass communication literature will be reviewed to determine the potential impacts of mass communication sources on attitude change in human communication networks.

After the network, mass communication, and group literature have been reviewed to determine the key variables that must be contained in a model, and relatedly the empirical findings any model must explain are examined; discrepancy models of attitude change will be reviewed. Discrepancy models have traditionally been used to examine attitude change in social

groupings (Abelson, 1964; French, 1956; Taylor, 1968). They have also received empirical support in a number of contexts (e.g. Danes et al 1978; Goldberg, 1954; Zimbardo, 1960). In discrepancy models attitude change is seen to be some function of the distance between initial attitudes and rate of contact of two communicators. The literature reviewed in this paper will suggest that this function is not only determined by these variables, but it is also determined by a number of group influence processes that need to be taken into consideration when these models are extended to human communication networks.

After the relevant literature is reviewed, mathematical models will be presented that incorporate the key parameters isolated from a review of the group influence, attitude change, mass communication, and network analysis literature. The general form of these models are predicated on these literatures and their ultimate predictions have been supported in a number of more specific empirical studies. The paper will conclude with a discussion of the relevance of these models for studies of attitude change in human communication networks, especially their relevance to organizational communication, mass communication, and diffusion research.

ATTITUDE FORMATION IN HUMAN COMMUNICATION NETWORKS

It is assumed here that attitude change is function of the amount of communication an individual has with particular sources. Thus, communication becomes a necessary condition for attitude change. Network analysis is a means of representing the interrelationships in any system. It is the general hypothesis of this paper that the structural configurations

of an individual's communication relationships pertaining to a particular attitude will have a determinative effect on its formation and change. Thus in this section a short discussion of the structural properties of networks related to attitude formation in a network will be presented.[2]

In any large social system there will be a natural tendency for a network to differentiate, to divide itself into more compact structural relationships related to particular tasks or functions (Katz & Kahn, 1966). These recurring groupings within a larger social system have been said to have a determinative effect on a number of attributes of individuals, including their time perspectives, orientation toward organizational goals, interpersonal orientation, and conflict resolution strategies (Lawrence & Lorsch, 1967), and, most importantly for this paper, their attitudes. If a social system is to maintain common attitudes on salient issues, which may be important for accomplishing its larger goals, there must be a high degree of linkage, or integration, within these groupings. In Abelson's (1964) view the crucial factor in determining the formation of attitudes in a communication network is the extent to which it is compact (highly differentiated) or diffuse (highly integrated) (See Figure 1). In a highly compact network individual attitudes come to reflect those of the groups to which an individual is a member, in a highly diffuse social system there will be a greater possibility for common attitudes to develop across the communication network (French, 1956).

These properties of differentiation and integration exist not only at the whole system level, but also at the group level. Groups can have communication linkages between every individual or they can be relatively differentiated with a minimal number of linkages between members. In the

small group literature two primary elements of structure have been identified. Composition, or the distributions among group members of certain properties, has been found to be related to potential group influence on attitudes in a number of contexts. For example, the following composition variables have been found to be related to attitude change: group size (which is directly related to the extent of differentiation) (Blake & Mouton, 1961 ; Edmonds, 1964; Feldman, 1972; Gerard, et al, 1968; Goldberg, 1954; Hare, 1952; Jacobs & Campbell, 1961; Khol & Nickols, 1971; Rath & Mishra, 1963; Rosenberg, 1961; Shaw, 1971; Stang, 1976; Witt & Zen, 1972); age (Bryant et al, 1963; Edmonds, 1964; Feldman, 1973; Luchins & Luchins, 1966; Strassberg & Wiggen, 1973); normative integration (the distribution of norms in a group) (Feldman, 1973); mixed sex group (Blake & Mouton, 1961; Rietan & Shaw, 1964); distribution of an attitude (Abelson, 1964; French, 1956; Shaw, 1971; Taylor, 1968); the homogeniety (homophily/heterophily) of group members (Altman & McGinnies, 1960; Festinger & Thibaut, 1951; Katz, 1957; Katz & Lazarsfeld, 1955; Klapper, 1957; Raven, 1959; Rogers & Shoemaker, 1972). All of these composition factors relate to the interrelationships that develop among group members. These interrelationships are most frequently conceived of in terms of communication linkages in network analysis. Communication in turn has been found to have effects on the attitude formation within groups with the following communication variables typically cited: channels of communication (Katz, 1957); amount of communication (Abelson, 1964); diffuse vs. compact networks (Abelson, 1964; French, 1958; Harary, 1959; Taylor, 1968) exposure to communication (Janis & King, 1954); and participation in discussion (Grove, 1965; Janis & King, 1954).

In sum, the structural properties of groups embedded in larger social

networks have a determinant influence on the attitudes of group members (Abelson, 1964; Allport, 1962; Altman & McGinnies, 1960; French, 1956; Harary, 1959; Shaw, 1971; Taylor, 1968).

Two general factors relating to the diffuseness of social networks result in changes in group attitudes and also changes in attitudes across the entire network. The first is the extent of overlap or linkage across the various distinct groups. The small group literature has long recognized that multiple group memberships (Cartwright & Zander, 1968; Killian, 1952) and the resulting anchorage of attitudes in various groups (Allport, 1962; Gerard, 1964; Katz & Lazarsfeld, 1955; Festinger, 1950; Raven, 1959) affects the extent to which any one group can induce change in the attitudes of their members. Thus increased linkages with other groups, or overlapping memberships, increases the dispersion of attitudes within any one group and will result in a stimulus for change in the attitudes of group members. Linkers, such as bridges and liaisons, in effect come to reflect attitudes that are a function of all of the groups with which they recurrently communicate; thus they are more cosmopolitan in conventional terms (Chaffee, 1979; Rogers, 1962). As such they act as change agents that impell the groups of which they are a member to adopt attitudes that more closely reflect those of the entire network. This is in effect the classic opinion leadership formulation stated in a slightly different way (Katz & Lazarsfeld, 1955).

Secondly, the notion of effective vs. extended networks (Epstein, 1961; Epstein, 1971) is useful in understanding the emergence of particular attitudes in networks.[3] Effective networks are those which involve group type linkages; it is in these networks that group influence processes come to the fore. These processes accelerate attitude

change or increase attitude stability. They will be the primary sources of attitude formation for the individual. But there isn't a one to one correspondence between effective and extended networks for all individuals within a system. Each network member communicates with a slightly different cluster of invividuals. These unique clusterings result in unique individual attitudes and as such are a constant stimulus for change within the network. But, individuals who do not have access to each other in the extended network, have indirect influence through their effect on others for which there is direct contact (French, 1956). Thus there is a ripple effect of diminishing influence for attitudes from any one source. As the information is communicating through extended zones, then the initial influence of the source is successively diminished by the attitude formation processes in each successive communicator, but if he is in a central position (such as that of a liaison or opinion leader) his influence can be widespread because of his direct linkages to a number of individuals in his first order zone (his direct contacts with other individuals) (Barnes, 1969).

In addition, to direct personal communication in any social network, at least in developed countries, there will also be mediated contact through various mass media channels, that have a direct bearing on the stability of attitude formation and of attitude change in networks. The literature has traditionally defined these mediated linkages as having unique properties when compared to direct linkages with other individuals. This is the topic of the next two sections, the impact of mass media and group influence on attitude formation in individuals.

THE EFFECTS OF COMPACT GROUPS ON ATTITUDE CHANGE

One of the predominant shibboleths of the current social science

literature is that interpersonal channels have more of an effect on attitude change than do mass media channels (Chafee, 1979). In this paper these interpersonal channels are conceptualized primarily in terms of an individual's effective network, that is those direct linkages that an individual has with others in his effective communication network.[4] However, most definitions of groups in the small group literature focus on the group qua group.[5] That is they seek to define the boundaries of memberships in collectivities. This approach to definition makes it difficult to conceptualize the effects of multiple group membership and the effects of recurring relationships with individual's who may not be in overlapping groups. Riley and Riley (1959) have suggested that a more fruitful definition of group, especially in terms of the effects of messages on individuals, would be one grounded or focused on the individual. This is the general approach taken in this paper when the focus is on an individual's effective communication network.

However, there is ample evidence that individuals value some of their communication contacts within this effective network more than others; this in part reflects more conventional definitions of groups. An individuals recurring relationships with others have a number of characteristics. They reveal particular purposes or functions, they are characterized by different degrees of affiliation, and their are varying degrees of recognitions of "groupness" within the collectivity. Thus, an individual can be a member of a family unit that is high on all of these factors and he can also simultaneously be a regular customer of a bar that will be relatively low on these factors. A group then can be defined more conventionally as a collection of individuals bonded together by a certain

degree of affiliation who have a structure of relationships between them that enables them to accomplish collective and individual purposes.

It is commonly recognized that multiple group memberships have important implications for an individual's behavior (Cartwright & Zander, 1968b; Killian, 1952). That is each group will have unique impact on the individual. To the degree that the groups correspond in their attitudes, or alternatively to the extent to which they are isolated in terms of salient attitudes, then the individual's attitudes should correspond closely to the attitudes of groups of which he is a member (Festinger & Thibaut, 1951; McKeachie, 1954). But if the groups to which he is a member differ in their communications regarding a particular attitude, then an individual's attitude will depart to a certain extent from the prevalent attitude of any one group (Allport, 1963; Festinger, 1950; Gerard, 1954; Katz & Lazarsfeld, 1955; Raven, 1959).

In this section key variables will be identified that determine the degree of influence that a group has on an individual's attitude. To this end the small group influence literature will be reviewed. It must be remembered that this literature essentially reflects a compact network; one that is isolated, or artificially formed, with communication from outside the group typically controlled by the experimenter. The final mathematical model will extend the variables identified here to larger social networks that represent the totality of the sources of communication concerning a particular attitude.

A number of variables have been cited in the literature as having a determinative influence on the attitudes of individual group members.

This list of variables is indeed so long that incorporating all of these variables into one model would be cumbersome at best, especially when additional variables related to outgroup sources and attitudes themselves must be incorporated in any model of the process. If the variables that have been identified in the literature could be integrated into a more general class of variables, or variables at higher levels of abstraction, without sacrificing their nature or the variance of the phenomenon they account for, then the result would be a much more elegant and parsimonious description of the phenomenon. This section will discuss three such variables--apprehension, strength and valuation--that can subsume the major variables that have been identified in the literature as representing the determinant influence of compact groups on attitude change.

Valuation

Valuation refers to the extent to which the group fulfills an individual's purposes and his affiliation needs. An individual's valuation of group membership is determined by the benefits he receives. The greater the benefits of the group in terms of the fulfillment of individual purposes and needs for affiliation the greater the potential the group has to induce attitude change in an individual. This variable has been suggested by Hovland, Janis, and Kelley (1953) among others (Dittes & Kelley, 1956; Katz & Lazarsfeld, 1955; Kelley & Volkart, 1952; Klapper, 1960).

The following variables, cited in the literature as influencing group members attitudes, appear to relate to the fulfillment of individual purposes and, hence, to the valuation of group membership: security (Hovland, Janis & Kelley, 1953); reward (Allport, 1962; Cartwright & Zander, 1968; Endler, 1966; Endler and Hoy, 1967; Jackson & Saltzstein, 1958;

Kelley & Volkart, 1952; Klapper, 1957; McKeachie, 1954; Riley & Riley, 1959); need for social approval (Jones & Tager, 1972; Moeller & Applezweig, 1957; Strickland & Crowne, 1962); motive satisfaction (Kelley & Volkart, 1952); consonance of individual locomotion with group locomotion (Festinger, 1950); purpose (Blake & Mouton, 1961; Festinger, 1950; Katz & Lazarsfeld, 1955); prior experience with contingencies of reward (Endler & Marino, 1972; Jones & Tager, 1972); and incentive to do well (Wyer, 1966).

A number of variables have also been said to relate to affiliation: need to be accepted (Argyle, 1957; Katz & Lazarsfeld, 1955); need for friendship (Katz & Lazarsfeld, 1955; friendliness (Shaw, 1971); group acceptance (Wyer, 1966); group belongingness (Cartwright, 1951; McKeachie, 1954); and group identification (McKeachie, 1954; Siegel & Siegel, 1957).

These additional variables can be viewed as being a function of the valuation of group membership: attraction to group (Back & Davis, 1965; Blake & Mouton, 1961; Bovard, 1953; Fauquier & Vinacke, 1964; Festinger & Thibaut, 1951; Festinger, et al., 1952; Gerard, 1954; Jackson & Saltzstein, 1968; Katz & Lazarsfeld, 1955; Kiesler, 1963; Kiesler & Corbin, 1965; Kiesler, et al., 1966; Wyer, 1966); cohesiveness (Altman & McGinnies, 1960; Back, 1951; Back, et al., 1963; Downing, 1958; Festinger, et al., 1952; French, 1956; Kelley & Volkart, 1952; Lott & Lott, 1961; Schacter, 1951; Shaw, 1971; Witt & Zen, 1972); fear of rejection (Raven, 1959); interpersonal integration (Feldman, 1973); functional integration (Feldman, 1973); commitment to continue (Kiesler, et al., 1966); and continuation of membership (Gerard, 1961; Kiesler & Corbin, 1965). All of these variables which relate to valuation, have been found to affect attitude formation in groups.

Apprehension

Apprehension represents the assignment of meanings to previously undefined or raw experiences of objects. From the perspective of the group apprehension involves the perceptions of an individual's attitude toward a particular object. From the individual's perspective apprehension represents the process by which the individual determines the group's attitude toward a particular object. The relative disparity between the apprehended attitudes has a determinant effect on the extent to which a group can influence an individual's attitudes. Members must be able to perceive the group's attitude or the position the group wishes them to adopt before they can feel the need to change their attitude. The group in turn must be able to perceive the individual's attitude correctly so that it can direct influence attempts at the individual. The issue of private vs. public committment to the attitude deals with the perception of the group of the attitudes held by individuals. If the group can't perceive that an individual holds a deviant attitude, for whatever reason, then it won't be able to institute the mechanisms and the processes that are designed to bring the individual in line. Ultimately it is predicted that the greater the correspondence between the group's and the individual's apprehended attitudes the less the overt pressure to uniformity.

Apprehension is a function of a number of variables that have been cited in the literature as having a determinant influence on the attitudes of individual group members. These variables appear to be subsumed by apprehension: exposure to social norm (Goldberg, 1954); clarity of group goals (Raven, 1959); clarity of group procedures (Raven, 1959); congruence[6] (McKeachie, 1954); content[7] (Dittes & Kelley, 1956; Raven, 1959); perception

of other member's attitudes (Allport, 1962; Altman & McGinnies, 1960; Mouton, et al., 1956); perceived group norm (McKeachie, 1954); public vs. private committment (Argyle, 1957; Asch, 1956; Blake & Mouton, 1961; Cervin, et al., 1961; Feshbach, 1967; Hollander & Willis, 1967; Kelley & Volkart, 1952; Mouton, et al., 1956; Raven, 1954); selective perception of content (Raven, 1959); conspicuousness (Witt & Sen, 1972); pressure to communicate (Simon & Guetzkow, 1955); public attitude initially taken Gerard, 1964; Blake & Mouton, 1961); perception of self as deviant (Carter, et al., 1967); and perception of group movement to deviant (individual's) position (Carter, et al., 1967).

Strength

Strength refers to firmness with which an attitude is held. The greater the strength with which an individual holds an attitude the less the potential influence of the group. The greater the strength with which a group holds an attitude the more likely it is that the group will be able to influence an individual's attitude. Strength is related to resistance, persuasibility, salience, value of the attitude, and the importance of the attitude.

One element of strength is the nature of the stimulus; that is how confident or sure is the group member of his judgment of the stimulus? A number of variables in the literature can be associated with this element; the ambiguity of the stimulus (Allen & Crutchfield, 1963; Allen & Levine, 1968; Dittes & Kelley, 1956; Endler & Hoy, 1967; Graham, 1962; Hollander & Willis, 1967; Luchins & Luchins, 1966; Shaw, 1971); nature of stimulus (Asch, 1956; Blake & Mouton, 1961; Endler, 1965); confidence in opinion (Brodbeck, 1956; Festinger, et al., 1952; Shaw, 1971); evidence (Gerard

1954; Luchins & Luchins, 1966); familiarity with stimulus (for both the group and the individual) (Myers & Arenson, 1968); experience with task (Edmonds, 1964); prior experience with stimulus without group (Sherif, 1935); ability (Back, et al., 1963); certainty of judgment (Boomer, 1959; Edmonds, 1964; Graham, 1962; Kelley & Lamb, 1957); uncertainty (Deutsch & Gerard, 1955); perceived competence at task (Smith, 1961); number of alternatives (Feldman & Goldfried, 1956; Witt & Sen, 1972); low expectation of success (Crowne & Liverant, 1963); and difficulty of problem (Edmonds, 1964).

A number of variables in the literature are associated with the strength with which the group holds a particular attitude: group consensus (Edmonds, 1964); unanimously wrong majority (Asch, 1956); relevance (salience of attitude to group) (Cartwright, 1951; Cartwright & Zander, 1968; Klapper, 1960; Schacter, 1951; Simon & Guetskow, 1955); unanimity of group (Blake & Mouton, 1964; Feldman & Goldfried, 1962; Hollander & Willis, 1956); presence of dissenter (Allen & Levine, 1968; Gorfien, 1964; Kiesler, et al., 1966); extent of prior uniform agreement of group (Hollander, et al., 1965); and majority/minority structure (Cvetkovich & Baumgardner, 1973).

A number of variables cited in the literature are associated with the strength with which an individual holds a particular attitude: extent to which group serves as frame of reference for individual (Sherif, 1935); anchorage of opinion in other groups (Kiesler, 1962; Raven, 1959); anchorage of opinion in group (Allport, 1962; Katz & Lazarsfeld, 1955; Gerard, 1954); importance of task to individual (Back & Davis, 1965); readiness to change one's opinion (Festinger, et al., 1952); degree of internalization (Kelley & Volkart, 1952); receptivity (Simon & Guetskow, 1955); prior experience with group (Rosenberg, 1961); involvement (Rule & Renner, 1968); reliance on

others for decision (Blake & Mouton, 1964); other person referents (Gerard, 1954); and social reality (Festinger, 1950; Katz & Lazarsfeld, 1955).

Summary

In this section the small group influence literature has been reviewed to isolate key variables that affect attitude change in members of compact groups. Three variables--apprehension, strength, and valuation--appear to subsume a large number of variables that have been cited in the literature to explain the relationship between group processes and group member attitude change. But out-group message sources can still have an effect on attitude formation, in some instances even a determinant effect. In the next section the mediating role of groups on outside messages will be discussed in more detail, with special emphasis on the situations in which these out-group messages can have important effects on attitude formation.

THE DIFFERENTIAL EFFECTS OF GROUP AND OF OUT-GROUP COMMUNICATION IN INDUCING ATTITUDE CHANGE

While the small group literature typically focuses on compact groups that are in essence closed systems, the mass media and diffusion literature are concerned with the effects of out-group messages on social groupings. In fact, the relationships between and the interactions within mass media audiences are crucial for any explanation of mass media effects (Johnson, 1976; Salomon & Cohen, 1978; Schramm, 1971). Four assertions about the characteristics of mass media audiences are commonly accepted today by mass media researchers. One, individuals in a mass media audience are members of networks of primary and secondary groupings (Bauer, 1960; Corner, 1979; DeFleur & Ball-Rokeach, 1975; Friedson, 1953a; Johnstone, 1974;

Katz, 1957; Katz & Lazarsfeld, 1955; Klapper, 1957; Riley & Flowerman, 1951; Riley & Riley, 1959; Trohldahl, 1966; Wright, 1959). Two, these networks influence the opinion of individuals (Back, 1963; Baur, 1960; DeFleur & Larsen, 1958; Friedson, 1953b; Johnstone & Katz, 1957; Katz & Lazarsfeld, 1955; Riley & Flowerman, 1951; Riley & Riley, 1959; Wright, 1959). Three, at the moment of exposure to mass media individuals in the audience are often participating in group experiences (Back, 1963; Friedson, 1953b; Riley & Flowerman, 1951; Wright, 1959). Four, at times the social network that an individual is embedded in gives him access to mass communications which he does not experience directly (DeFleur & Ball-Rokeach, 1975; Katz, 1957; Katz & Lazarsfeld, 1955; Riley & Flowerman, 1951; Rogers, 1962; Wright, 1959). All these assertions recognize that it is impractical to characterize the audience as an atomistic mass of isolated individuals, conversely any understanding of attitude change in social networks also must take cognizance of the role of mass media sources.

It is generally accepted that mass media and group (or interpersonal) channels have different roles in inducing attitude change. While their effects may be different, they can act together to form attitudes that are commonly sought (Rogers, 1962). However, the potential effects of groups mitigates against the mass media having a direct and immediate effect on the attitudes of individuals when there are conflicting messages about the same attitude for "the effectiveness of the mass communicative act, depends in determinable ways on the degree to which the media are linked to interpersonal networks and the characteristics of those networks" (DeFleur & Larsen, 1958).

"In sum, the weight of empirical evidence favours a view of media use as frequently accompanied by personal contact with others and subject

to group norms and sanctions" (McQuail, 1969; 56).

> Ordinarily, he (the audience member) is a member of a network of primary and secondary groupings--his family, friendship groups, occupational circles, and so on--which influence his opinions and attitudes. Inevitably, they affect the way in which he is exposed to mass communication, how he interprets or reacts to specific communication, and the extent to which he will or can modify his behavior in compliance with the message" (Wright, 1959; 50).

In general, the mass media literature has traditionally identified six factors that differentiate interpersonal from mass media channels of communication concerning their relative effects on attitude change. One, the flow of messages from mass media sources is primarily one way, with little opportunity for immediate feedback or changes in messages depending on the reactions of receivers (Lazarsfeld, Berelson, & Gaudet, 1948; Rogers, 1962; Schramm, 1973; Westley & MacLean, 1955). For example, a group can increase the number of messages concerning the salient attitude once it apprehends that a member is wavering. One of the commonly noted phenomena of group life is the increased number of messages sent to a deviant after his deviancy is detected (Berkowitz & Howard, 1959; Festinger, et al., 1952). Two, interpersonal channels are inherently more capable of overcoming selective processes (Rogers, 1962; Schramm, 1973; Westley & MacLean, 1955). In addition, a number of empirical studies demonstrate that out-group messages that members attend to are often determined implicitly or explicitly by their group (Atkin, 1972; Johnstone, 1974; Riley & Flowerman, 1951; Riley & Riley, 1951). As DeFleur and Larsen (1958) have noted "his position and functioning in the social network of his community will condition what he hears and from whom" (p. 272). Three, mass media messages are interposed between source and receiver, thus fewer senses are used in apprehending the

message, reducing probabilities of reception (Rogers, 1962; Schramm, 1973; Westley & MacLean, 1955). Fourth, interpersonal channels allow for a greater possibility of influence; since they are both immediate and personal, more trust is likely to be given the source (Lazarsfeld, Berelson, & Gaudet, 1948). Fifth, persuasion can occur without conviction, that is a person may engage in the advocated activity, even though he doesn't feel strongly about it, merely to please the other party (Lazarsfeld, Berelson, & Gaudet, 1948). Sixth, interpersonal channels involve more homophilous communicators, increasing the probability of message reception and understanding (Chaffee, 1979; Rogers, 1962; Westley & MacLean, 1955).

In spite of all of these factors, the mass media can still act in a number of ways to change individual attitudes. First, by delivering messages simultaneously to all group members mass media can act to change the climate of opinion in an entire group, however slowly and imperceptably. Second, constant exposure involving repeated sending of the same message to individuals can gradually result in changed attitudes (Lang & Lang, 1962). This is one of the devices through which the mass media can maintain a deviant in the face of group pressures, in effect it can provide the member an anchor for the attitude outside of the group. Third, relatedly the mass media may serve to reinforce attitudes of entire groups, and thus of individuals within them (Back, 1963; Lang & Lang, 1972; McQuail, 1969; Silvey, 1970). Fourth, the mass media may serve to crystallize opinions (Back, 1963; Lang & Lang, 1972); compelling individuals to become cognizant of attitudes of which they were only vaguely aware.

Perhaps the most important role of mass communication in attitude formation is the provision of information from an expert, credible source on topics that either are novel or for which the group serves as an inadequate source (Chaffee, 1979). Woelfel et al. (1980) maintain that the amount of information that an individual possesses relevant to a particular attitude is crucial in determining the impact of messages in inducing attitude change. The more information an individual has concerning a particular attitude, the more resistant he will be to attitude change. This is reflected in the common finding of political behavior studies that individuals who have a great deal of accumulated information are unlikely to change their attitudes during political campaigns, but those individuals who are exposed to novel information are likely to change their positions (Sears, 1969) This is also seen in the strength of weak ties notion often discussed in diffusion research (Chaffee, 1979; Rogers & Argawala-Rogers, 1976). Individuals who are homophilous constantly talk about important issues, and in a compact network they come to reflect stable common attitudes. Thus change is unlikely to be stimulated within a group; however, heterophilous sources can result in change because of their differing perspectives. This is most likely to be true when an individual is confronting a risky, important decision that is relatively novel (Chaffee, 1979). In this situation mass media channels will be sought out that are credible and expert. If the information is not something recurrently discussed by the groups, this novel information can result in significant change in individuals.

In summary, mass media is often held to be important in the provision of information and content (Chaffee, 1979), but group channels are seen

to be the most effective in inducing immediate and direct attitude change (Katz, 1960; Rogers, 1962; Wright, 1959).

> Formal media will influence mainly by representation or by indirect attraction, that is, by what they tell. People, however, can induce each other to to a variety of activities as a result of their interpersonal relations and thus their influence goes far beyond the content of their communications. (Katz & Lazarsfeld, 1955)

SUMMATION OF POSSIBLE SOURCES OF COMMUNICATION RELATED TO A PARTICULAR ATTITUDE

Figure 2 contains a graphical representation of an effective network for focal person A. This paper postulates, based on the literature, that A's attitudes will be a function of all his communication about the attitude in his effective network. These direct linkages with other sources can be initiated by others in the network or by the focal person. Most previous formulations of attitude change in human communication networks have focused on persuasive attempts directed at the individual, but it is just as likely that linkages will be initiated by the individual (Chaffee, 1979). This seeking of information from his effective network is in part a function of accessibility, but it also depends on the uses and gratifications that an individual accrues from using particular sources, which for the group relates to valuation and for the media relates to their novelty and credibility.

It has generally been maintained that group sources, because of their homophily and interpersonal influence will be the most determinant in inducing attitude change. The valuation, strength, and apprehension variables reflect the interpersonal influence of groups. Thus in the

example the individual's linkages with $G_{1, 2, 3}$, family members, and $G_{6, 7, 8, \& 9}$, members of his work team, would probably have the greatest impact on A. The amount of communication directed at the individual because of the recurring and redundant nature of these linkages should also be greater resulting in more influence as well. However, all members of the family have linkages to M_1, which could result in this group as a whole changing their attitudes in the direction of this source.

G_5 links A to an extended network of individuals to which he doesn't have direct ties. G_5's attitude is a function of his communication with the members of this extended network; thus the members of the extended network indirectly influence A through him. But because there is only one communication linkage with this extended network, and it isn't reinforced with other ties in an immediate grouping of which A is a part, G_5's influence should be less than that of the more compact groups of which A is a member.

A also has direct and indirect ties to sources not mediated by compact groups in his extended network. A has an indirect linkage to M_2, a print media source, through G_8. This is the classic example of the two-step flow of information from the media discussed in opinion leadership studies. A also has a direct linkage with M_3, a public affairs radio program, to which no one else in his effective and extended network has a link. The impact of these out-group communication sources will depend on the extent to which they provide A with novel, expert, or credible information (Chaffee, 1979), since they don't have the same degree of interpersonal influence as the group sources.

The attitudes that A will come to develop are a function then of all these communication linkages. This is a relatively simple example, containing the major types of sources that have been identified in several literatures.. However, natural effective and extended networks are likely to be much more complex. Thus conventional means of describing the effects of various sources, become very cumbersome when a holistic view of attitude change is sought. The remainder of the paper will focus on the development of a mathematical model that captures the impact of the variables that have been identified in several diverse literatures. The model synthesizes the effects of these sources in a parsimonious fashion that permits a more complete specification of the nature of attitude change in natural human communication networks.

DISCREPANCY MODELS OF ATTITUDE CHANGE

For the purposes of this paper an attitude represents a cognitive orientation toward an object that serves to differentiate it from other objects. The focus here is exclusively on attitudes; neither the behavioral or psychological concomitants of attitude change will be extensively examined. Thus the main theme of this paper is the change in orientation toward objects in individuals induced by communication with group and out-group sources. The mathematical model that will be developed in the next section is based on a particular class of attitude change models-discrepancy models (proportional change or contrast)-that have received empirical support and that have traditionally been used to examine attitude change in human communication networks.

The basic notion underlying contrast models is very simple. They assume that attitude change will be some function of the discrepancy

between the initial attitudes of two communicators. As individuals communicate over time about a specific attitude, their attitude will change by some function, usually proportionally, of the initial distance between them. This movement will be in the direction of attitude held by the source of the message (Abelson, 1964). Thus attitude change is primarily a function of the initial attitudes of the communicators and their rates of communication. For example, Abelson (1964; 143) uses the following expression for his discrepancy model:

$$\Delta_j (x_i) = k (x_j - x_i), \text{ with } k > 0 \qquad (1)$$

where Δ_j = change in i's attitude following contact with $_j$ about it.

k = a personality constant.

A number of empirical studies have demonstrated support for this model (Aronson, et al., 1962; Cohen, 1959; Fisher & Lubin, 1958; Goldberg, 1954; Hovland et al., 1957; Hovland & Pritzker, 1957; Laroche, 1977; Zimbardo, 1960). Discrepancy models of attitude change have been used in a number of theoretical formulations of influence processes and attitude change in communication networks (Abelson, 1964; French, 1956; Taylor, 1968). The predictions of these models are also reflected in the small group influence literature (Festinger, 1950; Festinger, et al., 1952; Festinger & Thibaut, 1951; Grove, 1965; Harary, 1959; Hare, 1952; Kiesler, 1963).[8]

The very elegance and simplicity of the discrepancy model has raised doubts about its efficacy;[9] but, given slightly different assumptions, it can be used as a basis for more complicated models. One such formulation is the assimulation-contrast model, or social judgment

model (Sherif & Hovland, 1961; Sherif, et al., 1965). There has been some empirical support for social judgment models (Derlaga, 1972; Fauquier & Vinache, 1964; Insko, 1967; Kiesler, et al., 1969; Nemeth & Markowski, 1972; Rules & Renner, 1968; Zolman et al., 1960). Social judgment approaches postulate that the initial distance between two communicators is the determining factor in eventual attitude change. If the discrepancy is too great there will be a boomerang effect, and the attitudes of the interactants will grow further apart.[10] The closer the initial attitudes, the more likely it is that they will be seen as essentially similar and assimilated. The main thrust of this paper will be towards the discrepancy model because of its greater elegance, but the tenents of social judgment models can be incorporated in the final mathematical model that will be developed.

Another modification of discrepancy models is the accumulated information model. It hypothesizes that there is an inverse relationship between the amount of information possessed concerning a particular attitude and the degree of change after communication related to it (Saltiel & Woelfel, 1975). Thus the accumulated information that an individual possesses acts to accelerate or dampen the rate of change based on the discrepancy between source and receiver. In Saltiel & Woelfel's (1975) formulation of this discrepancy model k in Abelson's model is replaced by α, a constant of proportionality that depends on the discrepancy of the belief value communicated and the original belief held by the receiver. When this parameter reflects the accumulated information of the receiver it takes the following form:

$$\alpha_N = \frac{1}{N} \qquad (2)$$

Where N equals the number of messages ever received on a topic. Danes et al. (1978) note that the number of messages received is often unknown,

so they use a modified discrepancy model that incorporates information as a continuous variable:

$$b_o = (M - b_o) / (1 + i_o) \qquad (3)$$

Where b_o represents the initial belief of the receiver, M represents the attitude advocated by a mass media message and i_o is the receiver's level of information at the time of the message. Danes et al (1978) found that this addition to the discrepancy model resulted in an enhanced fit of it to belief change following exposure to a mass media message. This formulation also appears to be evidenced in research related to attitude change during political campaigns (Sears, 1969) and the strength of weak ties notion of diffusion research (Rogers & Argawala-Rogers, 1976). The final mathematical model can be couched both in the traditional discrepancy formulation, which is more parsimonious, or in the accumulated information modification.

A MATHEMATICAL MODEL OF ATTITUDE CHANGE IN HUMAN COMMUNICATION NETWORKS

Now that the relevant literature has been reviewed the foundation has been laid for the presentation of mathematical models of attitude change in human communication networks. The final models presented in this section are derived primarily from the work of French (1956), Abelson (1964), and Taylor (1968). French's model is the most primitive of the three mathematically, but the essential assumptions, variables, and predictions of his model are quite similar to those of Abelson and Taylor. Abelson's model is quite sophisticated mathematically and his original article details the effects of the use of different variables and assumptions. Taylor's model is also quite sophisticated, he extends Abelson's model of change in human communication networks to include the effects of out-group messages on attitude

change. In this section the general form of these three models will be discussed. However, because of space limitations, the mathematical derivations of the models and their mathematical implications won't be detailed. The interested reader should consult the original works of these theorists for extended treatments of their models. Once these models are presented then several versions of a new model, incorporating the parameters developed in the preceding literature reviews will be developed. The implications of the incorporation of these new parameters, which reflect more closely the small group and mass media literatures, will then be discussed.

French's Theory of Social Power

French (1956) advances what he terms a formal theory of social power for compact groups. However, his theory is really concerned with the manner in which groups can influence the opinions of their members. It postulates that the influence process is a function of power relationships, communication networks, and the distribution of opinions that exist in a group. Most of his ideas are extended and refined in the models presented in this section. French assumes a discrepancy model of attitude change, where the change in two individual's attitudes, given that they are communicating with each other concerning the opinion, is some constant fraction of the distance between them. Thus "if the amount of influence attempted is held constant, the amount of change in the inducee increases with the increasing size of the discrepancy" (French, 1956: 184). French also advances a number of theorems concerning the eventual state of a group's attitudes given various initial distributions of attitudes and communication patterns. He postulates that given a completely connected group, the

group will eventually come to hold an attitude at a common equilibrium level equivalent to the arithmetic mean of the initial opinions. The more completely connected the group, the faster this equilibrium level will be reached. In a weakly connected group, the group will not reach a common attitude unless very special circumstances exist.

Abelson's Model of Attitude Change in Human Communication Networks

Abelson (1964) presents an extension of the early work of French that is supported by the empirical findings related to the discrepancy model of attitude change. Abelson's model is concerned with "the distribution of attitudes under the impact of social influence processes" (Abelson, 1964: 142). The model assumes an unidimensional[11] continuum of attitudes towards some issue. x_i and x_j denote the positions of communicators along this attitude continuum. "For a single contact between two individuals, the simplist assumption is that each member changes his attitude position toward the other by some constant fraction of the distance between them" (Abelson, 1964: 143). This is the assumption that Abelson makes. The model considers the influence of all those individuals who communicate with x in an n x n matrix. Abelson predicts that eventually all of the individuals in a compact network will come to hold the same attitude, in a diffuse network their will be bimodal or multimodal equilibriums dependant on the initial distributions of attitudes and rates of contact.

The following basic model sums over all individuals j and yields the net rate of change of x_i (an attitude x):

$$\frac{dx_i}{dt} = k \sum_j a_{ij} (x_j - x_i) \qquad (4)$$

where k = a personality constant

a_{ij} = the rate of contacts.

This is the simplest version of Abelson's model. Abelson also discusses a number of extensions of his model including: the effects of assuming differential personality constants based on the relative persuasibility and persuasiveness of the dyad, the effects of differential contact rates based on prior communications; and the effects of contacts with exogenous individuals.

Taylor's Extension of Abelson's Model to Include Out-Group Communication Sources

Taylor (1968) extends Abelson's basic model to include the effects of messages sent from outside the network. The only change that Taylor makes in Abelson's model of group influence is in a_{ij}. a_{ij} to Taylor reflects the rate of contacts concerning persuasion attempts (a_{ij}) and a personality constant (k_{ij}) related to persuasibility:

$$a_{ij} = k_{ij}\, a_{ij} \qquad (5)$$

This causes no substantive change, the mathematical expression for the model becomes:

$$\frac{dx_i}{dt} = \sum_{j(\neq i)=1}^{n} a_{ij} \quad (x_j - x_i) \qquad (6)$$

To incorporate the effects of out group communication sources, specifically the mass media, Taylor makes the following additions to the model:

$$\frac{dx_i}{dt} = \sum_{j(\neq i)=1}^{n} a_{ij}\,(x_j - x_i) + \sum_{k=1}^{m} b_{ik}(s_k - x_i) \qquad (7)$$

where b_{ik}, analogously to a_{ij}, is the product of the personality constant and the rate of contact with source s_k. s_k is the position of the source of the outside message of the unidimensional attitude continuum. In the trivial case where $s_k = 0$ for all k the effects of the model are the same as those for Abelson's model, that is, if there is a conpact network eventually everyone comes to hold the same attitude. In the other cases of the model, equilibrium points, or stable attitude distributions, can be reached, but their nature depends on the distributions of initial attitudes among the sources. Taylor extends this model to include assumptions based on social judgment models and to include variable rates of interaction.

The Abelson and Taylor models very elegantly account for the structural properties of networks, including differentiation, integration, composition, the effects of multiple group membership, and effective vs. extended networks.[12] They are empirically grounded in the findings of various studies related to discrepancy models, and can be extended to social judgment perspectives.[13] The Taylor model specifically recognizes the differences between group and mass media sources by incorporating two seperate expressions for them. The parameter k specifically includes psychological factors, similar to Anderson's (1971) concept of weight. The models also explicitly allow for reciprocal influence among pairs of communicators. However, the models are still to optimistic in their predictions of equilibrium points in human communication networks. A number of organizational studies (Danowski, 1974; Danowski & Farace, 1974; Lawrence & Lorsch, 1967; Payne & Mansfield, 1973) and observations from other social settings, suggest that there are natural forces that compel groupings within social networks to adopt multimodal distributions of

relatively stable attitudes, to account for these observed regularities it is necessary to incorporate several new parameters reflecting group, mass media, and accumulated information perspectives in a revised model based on French, Abelson, and Taylor's original work.

The Final Mathematical Models

There are three classes of group influence variables that need to be included in the model if the determinant influence of groups in attitude formation is to be accounted for: strength, valuation, and apprehension. The psychological strength with which an attitude is held in already included in parameter k of Abelson's and Taylor's model. To more closely reflect the influence of groups a new parameter, s, will be added to their models. The equation for this new parameter takes the following form:

$$s_{ij} = \left(\frac{k_j^n}{k_i} \right) \qquad (8)$$

where n = the salience of the attitude to the group.

k_i = resistance of the group member to attitude change (including Anderson's (1971) variable of weight).

k_j = interpersonal influence of group member

Thus for this new parameter s_{ij}, the more salient the attitude to the group and the greater a member's interpersonal influence, the more likely it is that a group will overcome any resistance by the focal person. This is supported by the group influence literature reviewed earlier.

Unlike Taylor, the rate of contact (a_{ij}), as in Abelson's equation (4), is separated from k and s_{ij}. Since these models build on relationships between pairs of individuals, much like network analysis is based on dyadic communication linkages, group effects are represented by the relative

influence of individual members. But there is a cumulative effect for groups associated with both a_{ij} and s_{ij} (and later v_{ij}). Groups are characterized by the recurring linkages they have with individuals in the network, thus their increased relative contact and the cumulative effect of their individual strengths, will increase the group's influence on the individual, over other more isolated linkages in the network. Thus in a large, compact group the cumulative value of $(s_{ij} \cdot a_{ij})$ would be relatively high, and in a small diffuse group the cumulative value would be relatively low. In addition, if a group had an unstable distribution of attitudes, then the effects of group members would be reduced since group members would be advocating different positions for the focal person. In this situation the focal person's attitude would reflect some function of all his contacts with group members. In general, the ultimate effect of s_{ij} and a_{ij} is to considerably accelerate attitude change in the direction of positions advocated by groups. Thus these parameters more closely represent the impact of group influence processes, as reflected in the preceding literature review, than Abelson's and Taylor's original k. The ultimate effect of these parameter is to increase the probability of multimodal distributions of attitudes in all save the most diffuse social networks.

The inclusion of the valuation of group membership will require a new parameter v. This parameter will indicate the extent to which all individuals in a network value their relationships with every other member. Naturally individuals who are members of groups will receive higher values on this parameter than other individuals, this increased weight for compact groups is also reflected in the a_{ij} parameter, since increased

contacts add increasing weight to it for any pair. The valuation parameter is a function of both the extent to which a group member fulfills a members affiliation needs (h) and the extent to which a member of his effective network fulfills an individual's purposes (p). Thus the expression for valuation of sources in an individuals effective network becomes:

$$v_{ij} = (h_{ij} + p_{ij} - h_{ij}p_{ij}) \qquad (9)$$

The -hp term in equation 9 controls for the interaction between these two variables. Now if the newly formulated s_{ij} and v_{ij} are multiplied with a_{ij}, the result is a new parameter c_{ij} that indicates the effect size of the proportional change, given a certain discrepancy. Thus Abelson's basic model is transformed to:

$$\frac{d_j x_i}{dt} = a_{ij}\, s_{ij}\, v_{ij}\, (x_j - x_i) = c_{ij}\, (x_j - x_i) \qquad (10)$$

In the trivial case when a_{ij}, or h and p = 0, there will be no influence. The greater the extent to which an individual fulfills anothers purposes and affiliation needs the greater will be the attitude change associated with communication between this pair of individuals. Thus this parameter increases the possibilities for diffuse networks with multiple equilibrium points, since these group influence variables are very likely to vary throughout the network.

One further change is required in Taylor's final model (equation 7) to reflect our earlier discussion of the small group influence and mass communication literature. Taylor's b_{ik} should be changed to include within its personality constant a variable reflecting the valuation of the

media. The review of the mass communication literature suggested that individuals will seek out expert, highly credible sources, especially when they are confronted with a risky, salient decision. This factor can increase the impact of the media, thus b_{ik} comes to reflect the credibility of the mass media as an expert source.

The preceding literature review suggests three versions of a mathematical model describing attitude change in social networks: one reflecting the apprehension variables and assimilation-contrast models, another reflecting the modifications of Abelson and Taylor's basic model, and the third incorporating accumulated information. Perhaps the best approach to the apprehension variable is to change the meaning of the x's in the modified Abelson and Taylor model to reflect the perceived attitude of the source, rather than his actual attitude. It is well known that people's positions on issues are distorted perceptually by others, this is reflected in the homophily notion in diffusion research. Individuals can also conciously or unconciously not communicate their attitudes (Chafee, 1979). In addition, assimilation-contrast views of attitude change note that individuals often will perceive others as having essentially similar attitudes to their own, thus they do not detect the true discrepancy between themselves and another communicator. As a result no attitude change is likely to occur, since there is no detectable discrepancy between the two individuals attitudes. Thus in the following model x' and s' denote the perceived attitude of the other party rather than the actual attitude:

$$\frac{dx_i}{dt} = \sum_{j(\neq i)=1}^{n} c_{ij} (x_j' - x_i) + \sum_{k=1}^{m} b_{ik} (s_k' - x_i) \quad (11)$$

This model is the most likely to result in pools of very disparate attitudes throughout the network.

The expression for the modified Abelson and Taylor models incorporating the proceeding changes and measuring the actual attitudes of individuals becomes:

$$\frac{dx_i}{dt} = \sum_{j(\neq i)=1}^{n} c_{ij} \ (x_j - x_i) + \sum_{k=1}^{m} b_{ik} \ (s_j - x_i) \quad (12)$$

This model is the most likely of the three to result in equilibrium points and stable distributions of attitudes, but there are still increasing possibilities in this modified version for multimodal distributions of attitudes.

Following Danes et al. (1978) the complete expression for the model that includes accumulated information is:

$$\frac{dx_i}{dt} = \sum_{j(\neq i)=1}^{n} c_{ij} \left(\frac{x_j - x_i}{1 + i_i} \right) + \sum_{k=i}^{m} b_{ik} \left(\frac{s_k - x_i}{1 + i_i} \right) \quad (13)$$

This model accounts for the observed importance of novel information in both political campaigns and diffusion research. It also takes into consideration the value of uncertainty reduction and those aspects of apprehension that relate to certainty and familiarity with the stimulus. Naturally this model could also reflect perceived rather than actual attitudes of the source. This model makes it more difficult to reach a common equilibrium point of attitudes for the entire network, but it should be more likely than the apprehension model to result in stable attitude distributions throughout the entire network. The model reflects the importance of compact groups, or an individual's extended network, since these recurring relationships with others are most likely to contribute to an individual's information base,

which is going to determine the capacity of messages to affect a change.

Summary

The three different versions of the final mathematical model of the effects of group and out-group communication on attitude change in human communication networks all constitute elegant,

descriptions of the phenomenon. The empirical findings in this area necessitate that any model that attempts to accurately describe the phenomenon be mathematical. It is only through mathematical descriptions that the direct impact of effective networks and mass communication, and the indirect effects of extended networks can be systematically represented. The final models describe the process by which attitude change in human communication networks is a function of an unlimited number of combinations of steps and sources, including reciprocal influence. Influence in the model can flow directly, it can be filtered through others and it can come from a number of sources. The models can account for or describe the outcomes of any conceivable combination of group and out-group sources of influence, including differential values for the parameters for every pair in the network. It states explicitly the mechanisms by which groups exercise influence over their members and also provides an explanation for the observed 'pooling' of attitudes in any large social system. In fact, any schema that describes aggregate attitudes change, without taking cognizance of the divergence of attitudes in any large system, is repeating the fallacies of early mass media theories of treating large collectivities as isolated individuals, without the social ties that have determinant effects on attitude change.

SUMMARY AND IMPLICATIONS

The early sections of the paper isolated key variables that influence attitude change in social networks from the relevant network analysis, small group influence, mass media, and attitude change literatures. The review of the group literature identified three key variables-valuation, strength, and apprehension - that have been found to relate to attitude change in compact groups in a number of settings. A comparison of the effects of mass media and of group sources of communication indicated that the former was primarily associated with the provision of credible, novel information and the later was primarily associated with group influence processes. The literature has identified sufficient differences in the nature of group and out-group sources to justify separating expressions for their effect in any model of the process that is developed. A selective review of the attitude change literature isolated three key variables-rate of contact, accumulated information, and the discrepancy between the initial attitudes of two communicators - that appear to determine attitude change in social networks.

These variables were included in mathematical models which make possible greater precision in the analysis of this process. They incorporate effects of group and mass media sources, a weakness in most previous models; they can be examined over multiple points in time; they can examine all possible combinations of sources and of channels of influences; and finally, they allow for greater precision in estimation, prediction and analysis of effects. The models include implicitly or explicitly, all of the major

variables that have been identified in the literature reviews.

Implications for Small Group Studies

Most of the literature related to small groups ignores the possible ramifications of out-group communication for attitude change among group members. Communication from outside of the group may provide the antecedent conditions that determine deviancy among group members; that can maintain a deviant in the face of group pressures to uniformity; and that, further, can change the norms of the group as a whole either through simulataneous transmission to all the group members through the mass media or through exposure to information from extended networks of individuals. In fact, individuals in groups may not talk about attitudes that they develop that aren't salient to the group, this necessarily limits group influence. It has also been noted that members of social groupings do not pass on information from the mass media to the group as a whole that they assume everyone is aware of (Chaffee, 1979). Thus it is quite conceivable that groups and the mass media perform differential functions in their communication, with the group's communication related to one set of issues and relatedly determining the selection of mass media channels concerning them and the mass media providing group members information that the group can't provide, and thus primarily determining attitudes related to these issues. It is only when an individual is subject to conflicting information from group and mass media sources that the variables of strength, apprehension, and valuation, are likely to play a determinant role in giving supremacy to group influence.

Implications for Mass Media and Diffussion

The primary advantage of this approach over traditional mass media formulations is that it overcomes their artificial, and at times arbitrary,

conceptualizations of the process. Attitude change in social networks that results from mass media is in actuality a multiple-step process (Rogers, 1973) in which the influence of individuals is relative (Rogers, 1962; Schramm, 1973), not absolute, as in the two-step flow opinion leadership approach. It is at best a very limited picture of reality that individuals in social groupings rely on other individuals to mediate, or transfer, information from mass media channels to others in a human communication network. Individuals often attend to the media simultaneously and they also tend to be very selective in the information they pass on to others (Chaffee, 1979). One of the reasons that mass media has clung to the opinion leadership formulation is that it allows the categorization of individuals, which has traditionally been an approach to theory in mass communication (Schramm, 1973), and it deals, however awkwardly, with the issues of the mediating influence of groups. But instead of looking at group influence processes, and the dynamic interplay of influence in a network, opinion leadership approaches posit an individual that is the repository of these processes. The model that has been developed here permits the examination of multiple channels of influence, multiple intermediaries, and allows for the specific inclusion of interpersonal influence in a very parsimonious fashion. Thus it permits the examination of every conceivable type of media situation.

In addition, to the problem of the artificiality of the channels and their relative impact, opinion leadership formulations also have attempted to reify certain individuals in the social network. This formulation implies active seekers of information and passive acceptors or followers (Rogers,

1962; Schramm, 1973). But in the formulation developed here everyone in a social network has the capacity to influence to some degree. Thus this approach moves more explicitly and systematically into more modern notions of pluralistic leadership, a direction that opinion leadership has been heading in examining monomorphic vs. polymorphic opinion leadership (Richmond, 1980).

So opinion leadership should be thought of as a continuous concept (Rogers, 1962), with every source in a network having some relative degree of influence. Similarly everyone in a network should be thought of as both an information seeker and an information provider. There is some evidence that persuasive communication is not a one-way street, that the more one attempts to persuade his fellows, the more likely it is that he in turn will be subject to counter-persuasion attempts (Chaffee, 1979). It is likely that seeking information enhances the chances that someone may move in the direction of the selected source, but this has more to do with characteristics of the source and the willingness of the seeker to be persuaded. Similarly if someone is subject to a persuasive message he doesn't initiate, it may diminish the change induced by the message, but again this is attributable to other parameters already identified in the model.

Increasingly opinion leadership formulations are coming to recognize the importance of structural characteristics of the system of which the opinion leader is a part. For example, Richmond (1980) argues that opinion leadership is in part a function of the openness vs. closeness of the social system in which it is embedded. Thus in open systems there is more likely to be monomorphic opinion leadership, since individuals in the network have access to a number of differentiated sources that are likely to have developed specialized information as a result of their functions. In closed systems there is more likely to be polymorphic opinion leadership, that is information

seekers will turn to individuals who have generalized expertise because there hasn't been the same specialization of function, since differentiation is at least partially attributable to the very permeability of the systems boundaries (Katz & Kahn, 1966; Lawrence & Lorsch, 1967).

In fact opinion leaders may be change agents primarily because of the positions they occupy in a social network. Opinion leaders typically receive more information from diverse mass media and interpersonal sources than their fellows (Richmond, 1980; Rogers, 1973), thus they are more cosmopolitan because their attitudes come to reflect a unique summation of the attitudes imparted to them from the sources with which they communicate, thus when they communicate with sources from any one grouping they impart an attitude that is necessarily different than those of individuals in that group, thus their communications become an impetus to change for any grouping with which they communicate.

In sum, mass media and diffusion frameworks have traditionally conceptualized change in human communication networks in terms of opinion leadership. But opinion leadership is a very limited paradigm; it is applicable to only a narrow set of very specific circumstances. The mathematical model proposed here not only is applicable to opinion leadership, but also to the wider range of situations or channels in which attitude change in human communication network occurs. In addition, the model allows for a much more sophisticated and rigorous approach to attitude change in human communication networks.

Implications for Organizational Communication

Most of the comments made concerning the implications of this model for mass communication, diffusion, and small group influence literatures can also be extended to organizational settings, since diffusion of innovations

paradigms can be applied to them (Rogers & Argawala-Rogers, 1976) and since a substantial proportion of all the communication that occurs in organizations is mediated communication that occurs through print or other media channels. In fact, one of the classic examples of organizational research, the Hawthorne studies, deals primarily with the issue of the impact of out-group communication on a compact group. Perhaps the most important issue facing organizations in today's complex environment, is the balance between integration and differentiation. On the one hand organizations are compelled to differentiate into compact groupings, related to particular functions, in order to deal effectively with their environment and technological change (Katz & Kahn, 1966) and on the other the organization must integrate these functions to achieve an effective level of performance (Lawrence & Lorsch, 1967). If an organization fails to develop common attitudes on salient issues, such as the overall goals or direction of the organization, then it is likely to fragment and become incapable of effectively accomplishing interdependent performance among its sub-components. In applied settings or through the use of simulations, the model developed here could have important implications for organizational managers as to the kind and amount of integrating devices that should be used to achieve a unity of perspective and a resulting high level of collaboration that is crucial to organizational survival.

NOTES

1. This phenomenon is also reflected in studies of organizational climate, largely measured by attitudinal variables, which demonstrate widely differing climates associated with structural factors in organizations (Payne & Mansfield, 1973).

2. For a more detailed description of networks see Farace, et al. (1977), Barnes (196 or Rogers and Argawala-Rogers (1976).

3. French (1956) discusses this notion in a slightly different way in noting direct and indirect influence in networks. Direct influence occurs when individuals have direct communication linkages with others, indirect influence occurs through linkages mediated by other individuals. French (1956) maintains that direct linkages are more influential, with the strength of indirect linkages dependant upon the degree of influence exhibited in the initial direct linkage.

4. This definition is similar to the definition of communication group used in some approaches to network analysis (e.g. Farace et al., 1977).

5. See Cartwright and Zander (1968a) and Shaw (1971) for reviews of definitions of groups.

6. Congruence is the relationship between an individual's attitude and his perception of the group norm.

7. The content that is actually expressed during the course of the group interaction, which Raven (1954) asserts is important to the ultimate perception of the group's attitude.

8. For a summary of recent psychological work on discrepancy models, including a description of the effects of such psychological variables as source credibility, ego involvement, plausibility, distraction and effort on proportional change see Laroche (1977). His work doesn't specifically apply to a social network framework, but it does relate discrepancy models to cognitive dissonance theory, social judgement theory, learning theory, and perception.

9. Others (e.g. Anderson, 1971; Fishbein & Ajzen, 1975) have argued persuasively for differing perspectives of attitude change. Indeed some of their notions (such as Anderson's weight) are implicitly or explicitly included in the models developed here, but they haven't directly linked their formulations in the same systematic fashion as discrepancy models have to attitude change in social networks.

10. Woelfel et al. (1980) argue persuasively that the findings of social judgement and assimilation-contrast approaches are artifacts of unidimensional scaling; that is converging attitudes in a multidimensional space may be distorted in a unidimensional space to such an extent that they produce a boomerang effect.

11. Even the most ardent advocates of multidimensional scales for examining attitude change have used unidimensional scales for examining attitude change models of the sort described here (e.g. Danes, Hunter, & Woelfel, 1978). One apparently intractable problem related to the use of multidimensional scales in the type of model developed here is the likelihood

that any pair of individuals will have individual spaces of different dimensionality. Thus if discrepancies are to be calculated, then spaces have to be standardized across the network. This standardization is likely to produce similar distortions to the ones Woelfel et al. (1980) describe for unidimensional scales.

12. For a more detailed discussion of these properties of the models see Abelson (1964) and Taylor (1968).

13. Abelson (1964) and Taylor (1968) both discuss modifications in their basic models that reflect social judgement and assimilation- contrast approaches. For example, Abelson suggests the following modifications that would incorporate these notions in the models: one, assume change is inversely proportional to $|x|$ or, two, assume change is proportional to $(M^2-x_i^2)$, where M is a bound on the possible extremity of the attitude.

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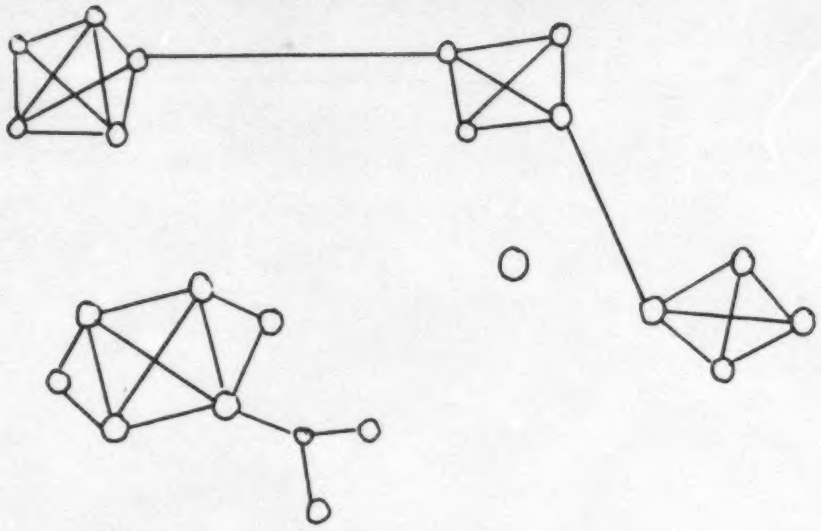
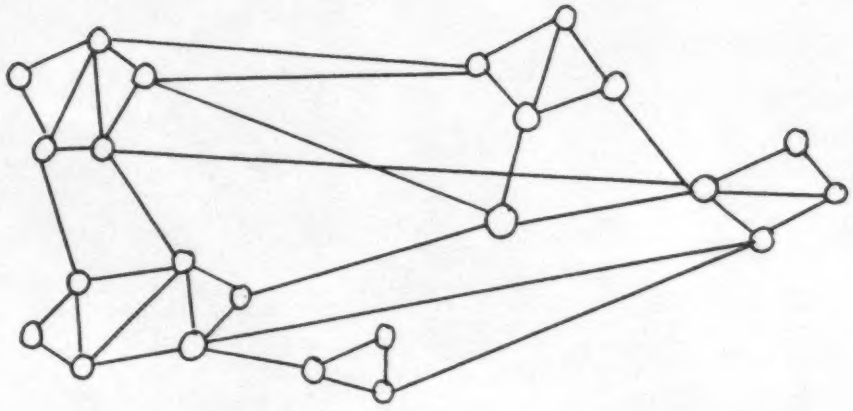


A. A Compact Network



B. A Diffuse Network

FIGURE 1

Graphical Examples of Diffuse and Compact Networks